OIPE
JAN 17 2006
IAP28
PATENT & TRADEMARK OFFICE

I, the undersigned, who have prepared English translation which is attached herewith, hereby declare that the aforementioned translation is true and correct translation of officially certified copy of the Korean Patent Application No. 2002-70705 filed on November 14, 2002.

This 4th day of January, 2006

Translator: Jo, Soung Mook

Jo, Soung-Mook

[ABSTRACT OF THE DISCLOSURE]

[ABSTRACT]

A plurality of spacers is formed on a panel for a liquid crystal display for supporting the panel. The spacers have at least two different heights or at least two different contact areas with the panel. The spacers include a plurality of first spacers and a plurality of second spacers having a height lower than the first spacers and having a contact area wider than the first spacers. The height difference between the first spacers and the second spacers is preferably in a range of about 0.3-0.6 microns, and the second spacers have a length larger than the first spacers preferably by 10-20 microns. Since the first spacers exhibit small compression deformation and are advantageous for dispersing the stress, they are capable of keeping a cell gap between the two panels uniform. On the contrary, since the second spacers exhibit large compression deformation, they facilitate to easily adjust an amount of LC for forming the liquid crystal layer.

[REPRESENTATIVE FIGURE]

Fig. 3

[INDEX]

liquid crystal, column spacer, liquid crystal assembly panel, liquid crystal cell gap

[SPECIFICATION]

[TITLE OF THE INVENTION]

PANEL FOR LIQUID CRYSTAL DISPLAY

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a plan view of a panel assembly for an LCD according to an embodiment of the present invention;

Fig. 2 is a sectional view of the panel assembly shown in Fig. 1 taken along the line II-II';

Fig. 3 is a sectional view of a panel for the LCD in a manufacturing method according to an embodiment of the present invention;

Fig. 4 shows exemplary locations of the spacers in the panel assembly according to an embodiment of the present invention;

Fig. 5 is a layout view of an LCD according to a first embodiment of the present invention;

Fig. 6 is an exemplary sectional view of the LCD shown in Fig. 5 taken along the line VI-VI'; and

Fig. 7 is an exemplary sectional view of the LCD to a second embodiment of the present invention.

[DETAILED DESCRIPTION OF THE INVENTION]

[OBJECT OF THE INVENTION]

[FIELD OF THE INVENTION AND CONVENTIONAL ART IN THE FIELD]

The present invention relates to a panel for a liquid crystal display, and in particular, to a liquid crystal display panel including spacers.

Generally, a liquid crystal display (LCD) includes two panels including field-generating electrodes and coated with alignment layers and a liquid crystal (LC) layer having dielectric anisotropy and filled in a gap (called a cell gap) between the panels. Electric fields are applied to the LC layer by using field-generating electrodes and the transmittance of light passing through the panels are controlled by adjusting the field strength, thereby displaying desired picture images.

The two panels are assembled by printing a sealant along a periphery of one of the panels and by hot-pressing the panels.

The cell gap between the panels is supported by elastic spacers provided between the panels and the sealant also includes spacers for maintaining the cell gap. The LC layer is encapsulated by the sealant. The spacers include spherical spacers spread on the panels and columnar spacers formed by photolithography.

In particular, it becomes important to keep the cell gap uniform and to facilitate the formation of the LC layer as the LCD becomes large.

[TECHNICAL TASK OF THE INVENTION]

It is a motivation of the present invention to keep the cell gap uniform of the LC layer.

[CONFIGURATION AND OPERATION OF THE INVENTION]

To achieve the above object, a panel for a liquid crystal display, which is provided, comprise a substrate, and at least one column spacer formed over the substrate, the at least one column spacer having a compression deformation equal to or larger than about 0.40 microns in response to about 5 gf.

The he contact surfaces of the column spacers may have circle shapes or rectangular shapes, and it is preferable that the at least one spacer has a contact area with the passivation layer in the range of about 600 to about 1,000 square microns.

The at least one column spacer may comprise a plurality of column spacers, and the concentration of the plurality of column spacers throughout the panel is about 250 to about 450/cm2.

The column spacers may have a height in the range of about 2.5 - about 5.0 microns.

The column spacers may have a tapered shape with an inclination angle in the range of about 20 - about 70 degrees

The panel may further comprise at least one gate line, at least one data line that crosses the at least one gate line, at least one thin film transistor electrically connected to the at least one gate line and the at least one data line, and at least one pixel electrode electrically connected to the at least one thin film transistor.

The panel may further comprise red, blue and green color filters sequentially formed on the substrate.

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. The present invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

In the drawings, the thickness of layers, films and regions are exaggerated for clarity. Like numerals refer to like elements throughout. It will be understood that when an element such as a layer, film, region or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

Now, panels for a liquid crystal display and manufacturing methods thereof according to embodiments of the present invention will be described with reference to the accompanying drawings.

In a method for manufacturing a display device including two panels, hot press process adhering the two panels to the plates, and pressing the two plates to attach two panels to each other, and vacuum compression process making the space enclosed by the sealant and two panels vacuous and exposing two panels to attach two panels to each other using the external atmosphere press are generally provided. Here, a plurality of spacers having the elasticity is arranged between the two panels to support the two panels with uniform interval, and the spacers may be spherical shape or column shape. The spherical spacers are dispersed on the panel and the column spacers are formed on the panel through a photolithography coating and pattering the photoresist. The column spacers may uniformly formed on the panel at the predetermined positions, and may wholly support two panels with uniform interval. Furthermore, the column spacers may uniformly support two panels with thin interval, and prevents the spacers from arranging in the pixel region so the characteristic of the display device is improved. The column spacers are pressed when the spacers supports two panels. However, if the sectional areas of the column spacers supporting the panels is small, and the compression deformation is large, the deformation of the column spacers are easily or the column spacers are breakdown, such that the cell gap between two panels is un-uniform. On the contrary, if the sectional areas of the column spacers supporting the panels is large, and the compression deformation is small, it is difficult to adjust an amount of LC for forming the liquid

crystal layer between two panels, such that the bubble is generated are the liquid crystal material is driven in the random position. To solve theses problems, the conditions for manufacturing the column spacers with the optimum conditions in the present invention.

At first, a panel assembly for LCDs according to an embodiment of the present invention will be now described in detail with reference to the drawings.

Fig. 1 is a plan view of a panel assembly for LCDs according to an embodiment of the present invention and Fig. 2 is a sectional view of the panel assembly shown in Fig. 1 taken along the line II-II'.

As shown in Figs. 1 and 2, a panel assembly 120 according to an embodiment of the present invention includes two panels 100 and 200 and a plurality of LC layers 300, a plurality of sealants 500, and a plurality of columnar spacers 400, which are disposed between the two panels 100 and 200.

The panel assembly 120 includes a plurality of, for example, four device areas divided by dotted lines A and B. The panel assembly 120 is separated into the respective LCDs by scribing the panel assembly 120 along the dotted lines A and B.

Each of the device areas (or an LCD) includes a display area 101, 102, 103 or 104 for displaying images. The display area 101-104 is substantially enclosed by the sealant 500, which confines the LC layer 300. The LC layer 300 may be formed after the panel assembly 120 which is separated into the respective devices.

The spacers 400 are provided for maintaining a gap between the panels 100 and 200 to be uniform and the sealant 500 may contain spacers for supporting the panels 100 and 200 to be parallel to each other.

As shown in Fig. 2, the spacers 400 have a compression deformation equal to or larger than about 0.40 microns in response to 5 gf and are compressed by about 0.2 microns. The concentration of the spacers 400 is about 250-450/cm^2.

In a method for manufacturing the LCD according to the embodiment of the present invention, the LC layer 300 may be formed in the panel assembly 120 before separating the panel assembly 120 into the respective devices, may be or not. Generally, when hot press process adhering the two panels to the plates, and pressing the two plates to attach two panels to each other is executed, the LC layer 300 is formed by injecting the LC material through an injection hole of the sealant after separating the panel assembly 120 into the respective devices.

On the other hand, when vacuum compression process making the space enclosed by the sealant and two panels vacuous and exposing two panels to attach two panels to each other using the external atmosphere press are provided, the LC material is dropped on one of two panels which is separated into the respective devices and the LC layer 300 is formed when two panels are attached through vacuum compression.

Now, a method of manufacturing the panel assembly according to embodiments of the present invention is described in detail with reference to the drawings.

Fig. 3 is a sectional view of a panel for an LCD according to an embodiment of the present invention, and Fig. 4 shows exemplary locations of the spacers in the panel assembly according to an embodiment of the present invention.

Referring to Fig. 3, a negative acrylic photoresist (not shown) is coated on a LC panel 100. An exposure mask (not shown) including an opaque film having a plurality of transmissive areas such as openings is disposed on the panel 100 with a predetermined distance. The photoresist is then exposed to light through the exposure mask and developed to form a plurality of spacers 400 at desired positions.

Each contact area between the spacer 400 and the panel 100 may be circular or tetragonal and has a magnitude preferably in a range about 600 to 1,000 square microns. For a circular contact area, the diameter of the circle is preferably equal to about 28-38 microns.

The height of the spacers 400 is about 2.5-5.0 microns and has a tapered shape with an inclination angle θ of about 20-70 degrees.

Since the spacers 400 have optimal compression deformation and are advantageous for dispersing the stress exerted on the panels 100 and 200, they are capable of keeping a cell gap between the two panels 100 and 200 uniform and they facilitate to adjust an amount of LC for forming the liquid crystal layer 300.

One of the panels 100 and 200 shown in Figs. 1 and 2 is called a thin film transistor (TFT) array panel provided with a plurality of gate lines (not shown) and a plurality of data lines (not shown) for transmitting electrical signals such as scanning signals and data signals, a plurality of TFTs (not shown) electrically connected to the gate lines and the data lines for controlling the data signals, and a plurality of pixel electrodes (not shown) receiving the data voltages for driving the LC molecules.

The other of the panels 100 and 200 shown in Figs. 1 and 2 is provided with a common electrode (not shown) facing the above-described pixel electrodes to generate electric fields for driving the LC molecules, and a plurality of color filters (not shown) for color display. The colors represented by the color filters are preferably includes three primary colors, i.e., red, green and blue.

The color filters and/or the common electrode may be formed on the TFT array panel and the common electrode on the TFT array panel may have a shape of a bar or a stripe.

Referring to Fig. 4, a plurality of red, green and blue color filters R, G and B are arranged in a stripe type. The spacers 400 are arranged in a regular or periodic manner along a row direction and a column direction. For example, the spacers 400 are preferably located between the same color filters of the red, green and blue color filters R, G and B by predetermined transverse and longitudinal distances, and the spacers 400 are preferably located on the gate lines, the data lines, or the TFTs.

An exemplary LC panel assembly according to an embodiment of the present invention will be described in more detail.

Fig. 5 is a layout view of an LCD according to a first embodiment of the present invention, Fig. 6 is an exemplary sectional view of the LCD shown in Fig. 5 taken along the line VI-VI', and Fig. 7 is another exemplary sectional view to a second embodiment of the present invention.

An LCD according to an embodiment of the present invention includes a TFT array panel 100, a common electrode panel 200, and a LC layer 3 and a plurality of column spacers 400 disposed between the panels 100 and 200.

The TFT array panel 100 is now described in detail.

A plurality of gate lines 121 for transmitting gate signals and a plurality of storage electrode lines 131 are formed on an insulating substrate 110.

The gate lines 121 and the storage electrode lines 131 extend substantially in a transverse direction and are separated from each other. A plurality of projections of each gate line 121 form a plurality of gate electrodes 123 of the thin film transistor, and the gate lines have a gate pad 125 which forms the end portion of the gate lines 121 and transmits scanning signal to the gate lines 121 from the external. Here, the storage electrode lines 131 are added, but the gate lines 121 may be extended to overlap a pixel electrode 190. At this time, the extended

portion of the gate lines 121 is used as one electrode of the storage capacitor to enforce the voltage storing capacity. When the voltage storing capacity is not enough, the storage electrode may be separately.

A gate insulating layer 140 preferably made of silicon nitride (SiNx) is formed on the gate lines 121 and the storage electrode lines 131.

A plurality of semiconductor islands 150 preferably made of hydrogenated amorphous silicon (abbreviated as "a-Si") or polysilicon are formed on the gate insulating layer 140. The semiconductor islands 150 are located opposite the respective gate electrodes 123.

A plurality of ohmic contact islands 163 and 165 preferably made of silicide or n+ hydrogenated a-Si heavily doped with n type impurity are formed on the semiconductor islands 150.

A plurality of data lines 171 and a plurality of drain electrodes 175 separated from each other are formed on the ohmic contacts 163 and 165 and the gate insulating layer 140.

The data lines 171 for transmitting data voltages extend substantially in the longitudinal direction and intersect the gate lines 121 and the storage electrode lines 131. A plurality of branches of each data line 171, which project toward the drain electrodes 175, form a plurality of source electrodes 173. A source electrode 173 and a drain electrode 175 in a pair are separated from each other and opposite each other with respect to a gate electrode 123. A gate electrode 123, a source electrode 173, and a drain electrode 175 along with the semiconductor island 150 form a TFT having a channel between the source electrode 173 and the drain electrode 175. The data lines have a data pad 179 connected to the end portion of the data lines 171 and transmitting the data signal to the data lines 171 from the external. A storage conductor pattern overlapping the storage electrode line 131 and connected to the pixel electrode 190 may have to enforce the voltage storing capacity, and the drain electrode 175 may be extended to use one electrode of the storage capacitor to overlap the storage electrode lines 131.

A passivation layer 180 is formed on the data lines 171 and the drain electrodes 175, and exposed portions of the semiconductor islands 150, which are not covered with the data lines 171 and the drain electrodes 175. The passivation layer 180 is preferably made of

photosensitive organic material having a good flatness characteristic, low dielectric insulating material such as a-Si:C:O and a-Si:O:F formed by plasma enhanced chemical vapor deposition (PECVD), or inorganic material such as silicon nitride and silicon oxide. The passivation layer 180 may have a double-layered structure including a lower inorganic film and an upper organic film for preventing direct contact between the semiconductor islands 150 and an organic film.

The passivation layer 180 has a plurality of contact holes 189 and 185 exposing end portions 179 of the data lines 171 and the drain electrodes 175, respectively. The passivation layer 180 and the gate insulating layer 140 have a plurality of contact holes 182 exposing end portions 125 of the gate lines 121. The contact holes 189, 182 and 185 can have various shapes such as polygon or circle. Also, it is preferable that the organic material is removed in the pad portion in which the gate pad 125 and the data pad 179 are disposed, this structure is more of benefit to a COA (chip on glass) which a data driving or and a gate driving chip are directly formed on the thin film transistor array panel.

A plurality of pixel electrodes 190 and a plurality of contact assistants 92 and 97, which are preferably made of ITO or IZO, are formed on the passivation layer 180.

The pixel electrodes 190 are physically and electrically connected to the drain electrodes 175 through the contact holes 185 such that the pixel electrodes 190 receive the data voltages from the drain electrodes 175. The pixel electrodes 190 supplied with the data voltages generate electric fields in cooperation with the common electrode 270, which reorient liquid crystal molecules disposed therebetween.

A pixel electrode 190 and a common electrode 270 form a capacitor called a "liquid crystal capacitor," which stores applied voltages after turn-off of the TFT. An additional capacitor called a "storage capacitor," which is connected in parallel to the liquid crystal capacitor, is provided for enhancing the voltage storing capacity. The storage capacitors are implemented by overlapping the pixel electrodes 190 with the storage electrode lines 131. The capacitances of the storage capacitors, i.e., the storage capacitances can be increased by providing a plurality of storage capacitor conductors, which are electrically connected to the pixel electrodes 190, between the gate insulating layer 140 and the passivation layer 180 opposite the pixel electrodes 190 and the storage electrodes lines 131.

The contact assistants 97 and 92 are connected to the exposed end portions 125 of the gate lines 121 and the exposed end portions 179 of the data lines 171 through the contact holes

189 and 182, respectively. The contact assistants 97 and 92 are not requisites but preferred to protect the exposed portions 125 and 179 and to complement the adhesiveness of the exposed portions 125 and 179 and external devices.

Portions of the passivation layer 180 near the contact assistants 92 and 97 may be completely removed, and such a removal is particularly advantageous for a chip-on-glass type LCD.

The description of the common electrode panel 200 follows.

A black matrix 230 for preventing light leakage is formed on an insulating substrate 210 such as transparent glass and the black matrix 230 includes a plurality of openings facing the pixel electrodes 190 and having substantially the same shape as the pixel electrodes 190.

A plurality of red, green and blue color filters 220 are formed substantially in the openings of the black matrix 230.

A common electrode 240 preferably made of transparent conductive material such as ITO and IZO is formed on the color filters 220 and the black matrix 230. The common electrode 270 covers entire surface of the panel 200.

Although Figs. 5-7 show the spacers 400 located on the data lines 171, the spacers 400 can be located on the gate lines 121, the TFTs, or any places covered by the black matrix 230.

The LCD may be a twisted nematic (TN) mode LCD where liquid crystal molecules in the liquid crystal layer 300 having positive dielectric anisotropy are aligned parallel to surfaces of the panels 100 and 200 and the molecular orientations are twisted from the surface of one of the panels 100 and 200 to the surface of the other of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is a vertically aligned (VA) mode LCD, that is, the liquid crystal molecules in the liquid crystal layer 3 with negative dielectric anisotropy are aligned vertical to surfaces of the panels 100 and 200 in absence of electric field. Alternatively, the LCD is an optically compensated bend (OCB) mode LCD, where the liquid crystal molecules have a bend alignment symmetrical with respect to a mid-plane between the panels 100 and 200 in absence of electric field.

The wider surfaces of the spacers 400 are in contact with the common electrode panel 200 as shown in Fig. 7 or in contact with the TFT array panel 100 as shown in Fig. 6.

A method of manufacturing a panel assembly for an LCD is now described in detail with reference to the drawings.

Referring to Figs. 5 and 6, a plurality of gate lines 121, a plurality of data lines 171, a plurality of TFTs, a plurality of pixel electrodes 190 and the like are formed on an insulating substrate 110 to form a TFT array panel 100. An organic insulating material is deposited on the panel 100 and patterned by photolithography to form a plurality of spacers 400 between the pixel areas. Meanwhile, a black matrix 220, a plurality of red, green and blue color filters 230, a common electrode 270, and so on are formed on another substrate 210 to form a common electrode panel 200. It is preferable that the size of the spacers 400 is equal to about 110-130% of the distance between the panels 100 and 200. The formation of the spacers 400 using photolithography enables to uniformly arrange the spacers 400 such that a thin uniform cell gap can be obtained throughout the panels 100 and 200 and the spacers 400 are prevented from being placed on the pixel electrodes 190, thereby improving the display characteristics.

Thereafter, a sealant 500 is coated on one of the panels 100 and 200 as shown in Figs. 1 and 2. The sealant 500 has a shape of a closed loop without an injection hole for injecting LC. The sealant 500 may be made of thermosetting material or ultraviolet-hardening material and may contain a plurality of ellipsoidal or spherical spacers for keeping the gap between the panels 100 and 200. Since the sealant 500 has no injection hole, it is important to exactly control the amount of the LC material. In order to solve any problem due to the excessive amount of the LC or the insufficient amount of the LC, a buffer region without LC material even after the termination of the panel combination is preferably provided at the sealant 500. Meanwhile, it is preferable that the sealant 500 has an anti-reaction film on its surface, which is not reactant with the LC layer 3.

A LC material is coated or dropped using a LC coater on the one of the panels 100 and 200 coated with the sealant 500. The LC coater may have a dice shape such that it can drop the LC material at the LC device areas 101-104. The LC may be sprayed on the entire surface of the LC device areas 101-104. In this case, the LC coater has a shape of a sprayer.

The panels 100 and 200 are delivered to an assembly device with a vacuum chamber. The room surrounded by the panels 100 and 200 and the sealant 500 is evacuated and the panels 100 and 200 are closely adhered to each other using atmospheric pressure such that the distance between the panels 100 and 200 reaches a desired cell gap. The sealant 500 is completely hardened with the illumination of a ultra-violet (UV) ray using a light exposure. In this way, the two panels 100 and 200 are assembled to form a panel assembly 120. The two panels 100

and 200 are exactly aligned to a minute order during the step of adhering the panels 100 and 200 and the step of illuminating UV ray on the sealant 500.

Finally, the panel assembly 120 is separated into the LC device areas 101-104 using a scribing machine.

[ADVANTAGE OF THE INVENTION]

As described above, the spacers supporting two panels are formed in the optimum condition. Accordingly, a cell gap between the two panels may be uniform, and may easily adjust an amount of LC for forming the liquid crystal layer.

[CLAIMS]

1. A panel for a liquid crystal display, comprising:

a substrate; and

at least one column spacer formed over the substrate, the at least one column spacer having a compression deformation equal to or larger than about 0.40 microns in response to about 5 gf.

2. The panel of claim 1, wherein the contact surfaces of the column spacers have circle shapes or rectangular shapes

3. The panel of claim 1, wherein the at least one spacer has a contact area with the passivation layer in the range of about 600 to about 1,000 square microns.

4. The panel of claim 3, wherein the at least one column spacer comprises a plurality of column spacers, and the concentration of the plurality of column spacers throughout the panel is about 250 to about 450/cm2.

5. The panel of claim 3, wherein the column spacers have a height in the range of about 2.5 - about 5.0 microns.

6. The panel of claim 3, the column spacers have a tapered shape with an inclination angle in the range of about 20 - about 70 degrees

7. The panel of claim 1, further comprising:

at least one gate line;

at least one data line that crosses the at least one gate line;

at least one thin film transistor electrically connected to the at least one gate line and the at least one data line; and

at least one pixel electrode electrically connected to the at least one thin film transistor.

8. The panel of claim 1, further comprising:

red, blue and green color filters sequentially formed on the substrate.